PROC. ENTOMOL. SOC. WASH.
90(3), 1988, pp. 373–392

DISTRIBUTION AND HABITAT COMPARISONS FOR *CARABODES* COLLECTED FROM CONIFER BRANCHES WITH DESCRIPTIONS OF *BREVIS* BANKS AND *HIGGINSI* N. SP. (ACARI: ORIBATIDA: CARABODIDAE)

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Abstract.—Seven species of *Carabodes* (*brevis* Banks, *dendroetus* Reeves, ***higginsi*** n. sp., *willmanni* Bernini, *granulatus* Banks, *niger* Banks and *labrynthicus* (Michael)) were collected from spruce and fir branches using the caustic soda wash technique. A redescription of *C. brevis,* a description of ***C. higginsi*** and distribution within North America for each species is included. Comparisons of branch samples with leaf litter/rotten wood samples from the forest floor clearly show that *C. brevis* and *C. dendroetus* prefer arboreal habitats. Additional evidence from literature and other collections indicate that *C. granulatus, C. labrynthicus* and *C. niger* may be arboreal depending on the presence of lichens, moss or fungi but *C. willmanni* may be arboreal only where lichens are present. Habitat preferences for ***C. higginsi*** could not be determined except that most specimens were collected in association with conifers.

Key Words: Oribatid mites, *Carabodes brevis, C. dendroetus, C. higginsi, C. willmanni, C. granulatus, C. niger, C. labrynthicus*

Oribatid mites are difficult to remove from arboreal habitats, especially evergreens with needles, with the conventional method of searching bark, branches or foliage. Often lichens, moss or various other organic accumulations adhere to branch surfaces obscuring vision. Fungi and lichens on the trunks of trees offer an easier habitat from which to collect. In Europe *C. labrynthicus* (Michael) has sometimes been collected from dry plants on rock surfaces (Seyd and Seaward 1984) and Bellido (1979) found all stages of *C. willmanni* Bernini burrowing into lichens. Travé (1963) found *C. labrynthicus* and *minusculus* Berlese more common in moss and lichens on rock and tree surfaces than in soil. The presence of certain species of *Carabodes* on the bark surfaces of trees or in lichens, fungi, moss, etc. attached to these surfaces is thus known, yet the extent of their distribution into the forest canopy has not been documented.

The caustic soda wash technique that resulted in the mite collections reported in this paper is used for second instar larval surveys of spruce budworm (*Choristoneura fumiferana* (Clemens)) (Miller and McDougal 1968). Briefly this technique requires clipping branches from the mid-crowns of host trees and immersing the branches in a 1% hot caustic soda solution for several hours to free larvae from their hibernacula. Much of the organic debris (needles, bark, etc.) is removed through sieving before the eventual sample is filtered in a Büchner funnel. Large numbers of mites on filter papers from branch samples subjected to the above process were brought to

my attention. I proceeded to remove mites as the samples were processed and time permitted. These samples were clipped on September 3/4 or 9/11, 1983 from red spruce (*Picea rubens* Sarg.) and balsam fir (*Abies balsamea* (L.) Mill.) at 10 different locations all within approximately 13 miles of Errol, Coos Co., New Hampshire. The amount of branch surface and whether lichens, fungi or moss were present on the branches is unknown.

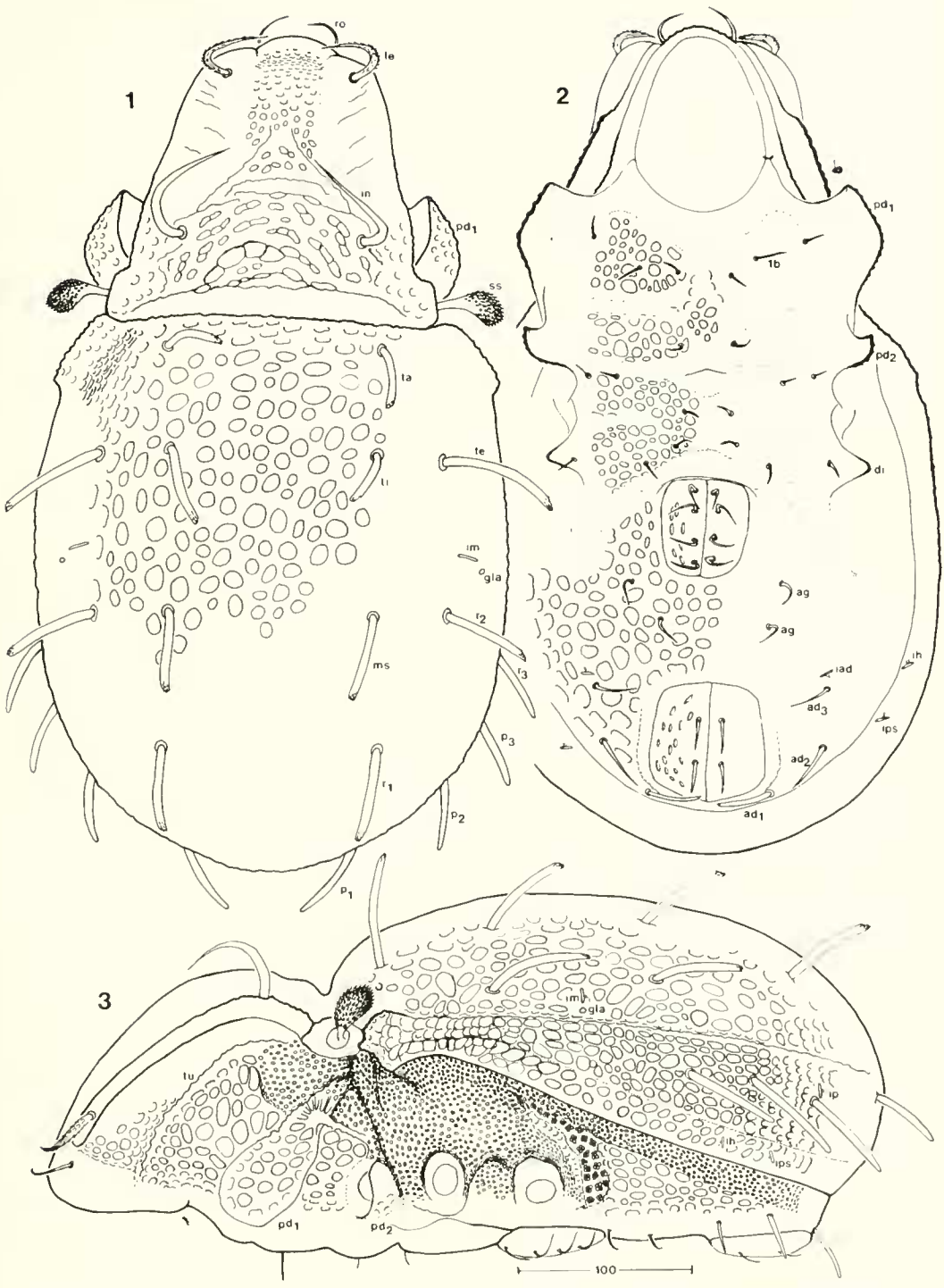
Among the mites collected from the branch samples were varying numbers of seven species of *Carabodes*. I had rarely encountered the two most abundant species, *C. brevis* Banks and *C. dendroetus* Reeves, in leaf litter/rotten wood collections indicating that they may prefer an arboreal habitat. Thus a comparison of species present in both habitats was appropriate even though differences in sampling methods did not allow statistical comparisons. Descriptions of *C. brevis* Banks and *C. higginsi* n. sp. are included as well as North American distributional records and habitat preferences for all seven species based on the literature, the author's collection, and the Canadian National Collection (CNC), Biosystematics Research Centre, Ottawa.

Terminology and abbreviations are those developed by F. Grandjean, as summarized by Balogh and Mahunka (1983). All measurements are in micromillimeters, and except for the holotype of *C. brevis*, are made from unmounted specimens. Specimen measurements are as follows: total length—tip of rostrum to posterior edge of notogaster, width—widest part of notogaster, height—from between genital and anal plates to highest point of notogaster, prodorsal length—tip of rostrum to posterior edge of dorsosejugal depression. Line drawings were made primarily from dissected specimens and may be a composite of more than one specimen. SEM's were made from mites stored in 70% ethyl alcohol, air dried, placed onto sticky tape on ½ inch aluminum stubs and coated with 200 Å AuPd in a Hummer IV Sputter Coater before observation in an AMR1000 Scanning Electron Microscope. Abbreviations of collectors names as follows: DSC—D. S. Chandler, RMR—R. M. Reeves.

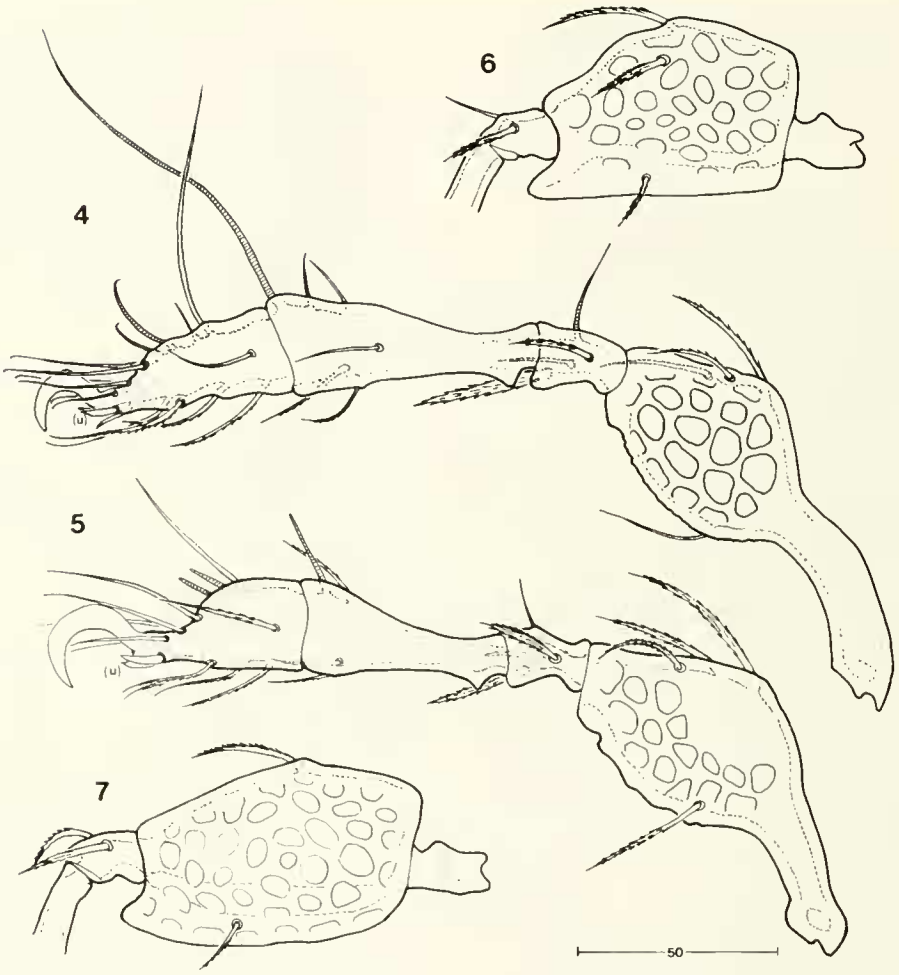
Carabodes brevis Banks 1896
Figs. 1–17

Diagnostic characters: Notogastral setae long, nearly uniform in diameter with only a few distal barbs; dorsosejugal depression of nearly uniform width between bothridia; sensillus short, capitate; notogastral pits of moderate size (5–12 diameter) and usually separated by less than the diameter of largest pit; two pairs of aggenital setae present.

Adult.—*Measurements:* Total length: holotype ♂ 500; "cotypes" ♀ 520, ♂ 545; other material examined (mean (range), n = 13 unless otherwise noted) ♀ 524 (470–580), ♂ 481 (450–520). Notogastral width: holotype ♂ 270; "cotypes" ♀ 300, ♂ 305; other material examined ♀ 296 (270–330), ♂ 274 (250–300). Height: holotype (not measured); "cotypes" ♀ 240, ♂ 240; other material examined ♀ 238 (210–270) (n = 12), ♂ 209 (185–245). *Integument:* Yellow brown, distinctly lighter in color than *C. niger* Banks. *Prodorsum:* Prodorsal length: holotype ♂ 175; "cotypes" ♀ 180, ♂ 190; other material examined ♀ 170 (140–185), ♂ 158 (135–185). Prodorsal surface (Figs. 1, 10, 11) with generally smaller pits than on center of notogaster, most uniform in area between lamellae, becoming indistinct on lamellar surfaces, the lamellar surface with weakly developed anterolaterally directed striations. Base of prodorsum between interlamellar setae with transverse folds which terminate in an inverted V-shaped fold near middle of prodorsum. Dorsosejugal groove present on posterior edge of prodorsum, width uniform between bothridial bases. Rostral setae (*ro*) arched medially, minutely barbed, 32–37 long. Lamellar setae (*le*) inserted near tip of lamella, arched medially, more strongly barbed than *ro*, 45–48 long. Interlamellar setae (*in*) inserted close to where inverted V-shaped fold

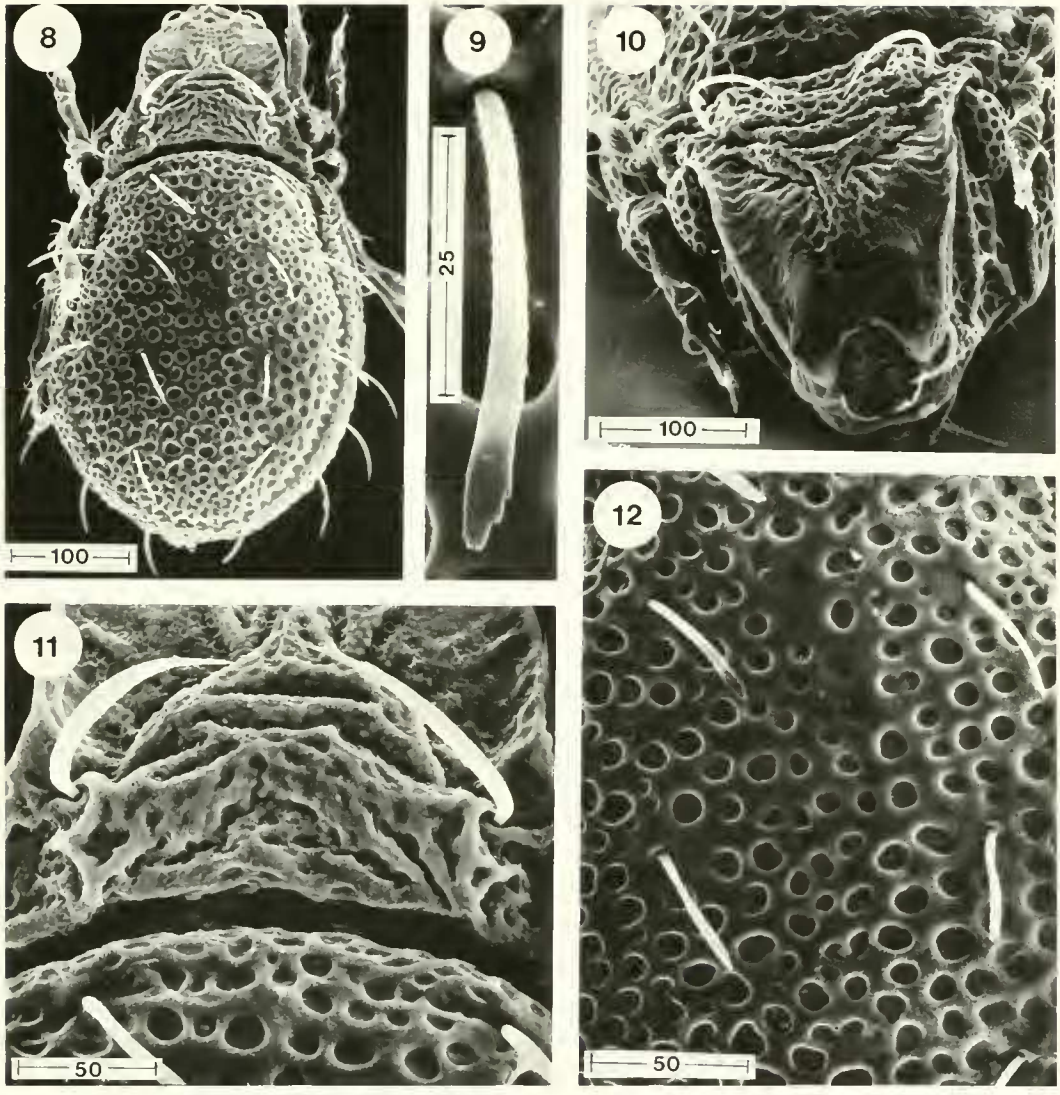


Figs. 1–3. *Carabodes brevis*, adult. 1, Dorsal view. 2, Ventral view. 3, Lateral view. Scale bar in μm.



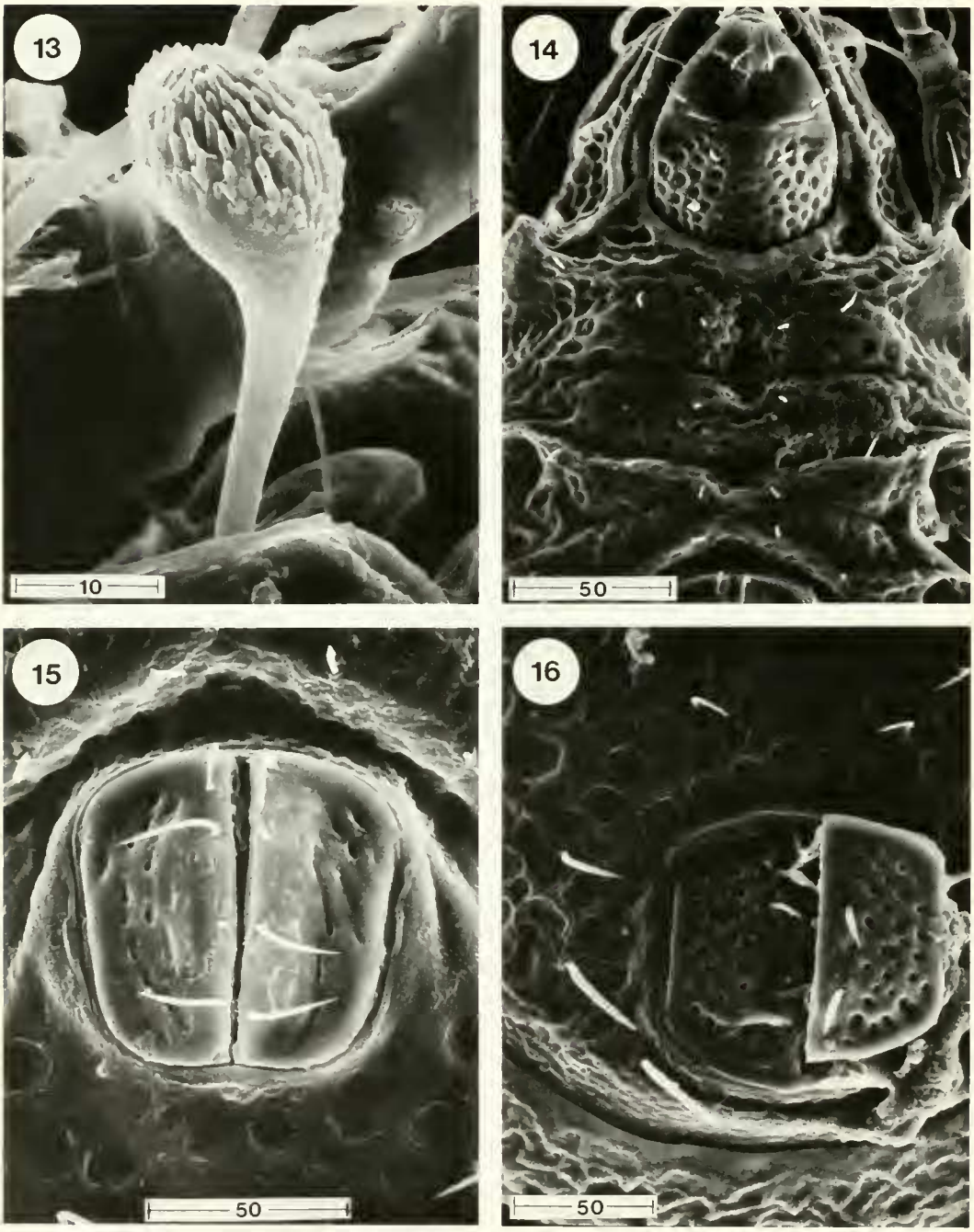
Figs. 4–7. *Carabodes brevis*, adult. 4, Leg I. 5, Leg II. Femur, genu, tibia and tarsus. 6, Leg III. 7, Leg IV. Femur and genu. Antiaxial views. Scale bar in μm.

begins, arched medially, acuminate distally, 82–88 long. Sensillus (*ss*) (Figs. 1, 13) short (length beyond bothridial opening 28–38), capitate, head spinose. Bothridial wall entire. Seta *ex* absent. *Notogaster:* Notogaster (Figs. 1, 8, 12) covered with round pits of variable size (5–12 diameter), inter-pit distance usually less than largest pit diameter. Pits less uniform in shape near edges of notogaster. Circumnotogastral depression (a depression parallel with lateral and posterior margins of notogaster) present (Fig. 8). Ten pairs of notogastral setae present (Banks (1896) erroneously notes that there are eleven pairs). All notogastral setae similar, long (*ta, ti* and *ms* extending at least half way to insertion of next posterior seta), nearly uniform in diameter, a few small barbs present at or near tip (minute bars on shaft seen only in SEM, Fig. 9), posteromarginal setae smoother at tip in dorsal view than central notogastral setae. Seta *ta* inserted anterior to *ti*, thus *ta, ti, ms* and r_1 form longitudinal row with *te* and r_2 forming a second parallel row laterally. (Banks' (1904, 1915) figures of *C. brevis* show only nine pairs of notogastral setae, one of the posteromarginal setae lacking, and the *te*-r_2 row is erroneously



Figs. 8–12. *Carabodes brevis*, adult. 8, Dorsal view (221×). 9, Seta *ti* (1910×). 10, Prodorsum, anterior view (394×). 11, Dorsosejugal groove detail (760×). 12, Pits on notogaster between *ti* and *ms* (580×). Scale bars in μm.

continued posteriorly in line with the posteromarginal setae.) Anterior notogastral setae slightly longer than posterior (50–55 vs. 40–45 respectively in "cotypes," 55–65 vs. 48–52 respectively in four specimens extracted from spruce branches). Position of *im* normal but gland *gla* sometimes ventrad of *im* (Fig. 3) or posterior to *im* (Fig. 1). *Gnathosoma:* Setal positions and pitting of ventral surface shown in Fig. 14. Palpal setal formula 0-2-1-3-9 (+1 solenidion). *Ventral surface:* Pits on epimera similar in size to those on prodorsum while pits on ventral plate similar in size to those on center of notogaster (Fig. 2). Pits on genital and anal plates much smaller than other ventral surface pits. Epimeral plates divided by furrows, enlarged depression in center of first



Figs. 13–16. *Carabodes brevis*, adult. 13, Sensillus (2530×). 14, Ventral view of gnathosoma and epimera (570×). 15, Genital plates (1114×). 16, Anal plates (760×). Scale bars in μm.

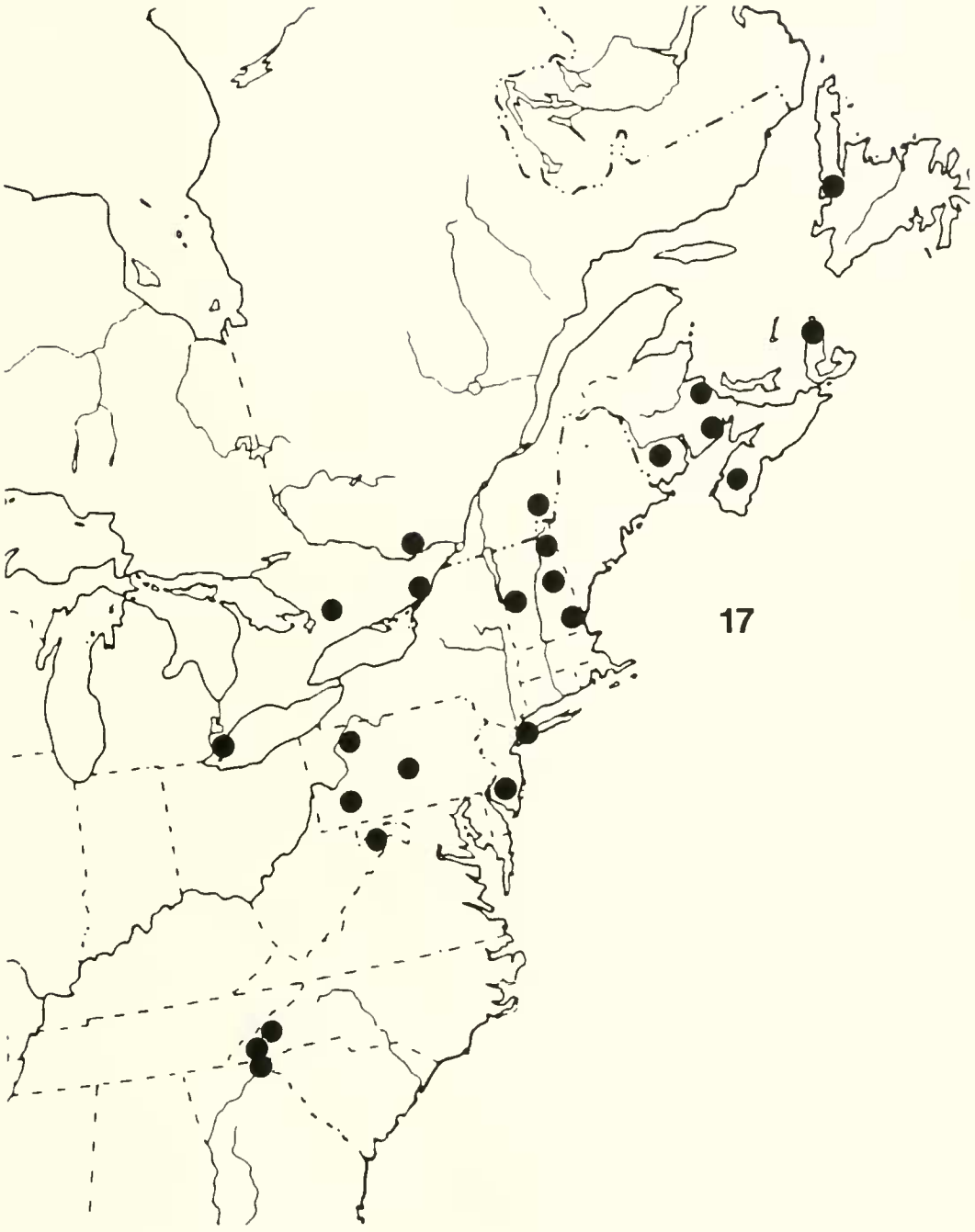


Fig. 17. Known North American distribution of *Carabodes brevis*.

two furrows (Figs. 2, 14). Epimeral setal formula 3-1-3-3, seta *1b* longest. Four pairs of genital setae, first pair directed posteriorly, others laterally, the latter extending ¾ distance to lateral edge of plate (Figs. 2, 15). Two pairs of aggenital setae (*ag*) on ventral plate (only one was found on one side of the male "cotype"). Two pairs of anal (*an*) and three pairs of adanal setae (*ad*) with ad_1 longest (length 35–40) and ad_3 shortest (length 20–25) (Fig. 16). Setal diameter increases from ad_3 to ad_1 with diameter of ad_1 similar to posteromarginal notogastral setae. Lyrifissure *iad* positioned anterior to ad_3. Pedotecta I and II (pd_1 and pd_2) and discidium (*di*) as shown in Fig. 2. *Lateral surface:* Generally surface below lamella, bothridium and edge of notogaster and above leg insertions with small tubercles; remainder with variously sized pits (Figs. 3). Area posterodorsad to insertion of leg IV with tubercles joined into groups of four or more. Pedotectum I covering base of acetabulum I, widest ventrally, tapering dorsally to near bothridial base. Ridge present above acetabulum II extends anteriorly onto pd_1 where it becomes palmate and demarcates tuberculate area dorsally and pitted area ventrally. Lyrifissures *ih* and *ips* on ventral edge of notogaster below r_3, p_3 and p_2 (Figs. 2, 3). Lyrifissure *ip* posterior and dorsal to insertion of p_2 (Fig. 3). Edge of ventral plate adjacent to notogastral plate with band of small tubercles. *Legs:* Pits present on antiaxial surfaces of trochanters III and IV, enlarged distal portion of femur I, lower half of enlarged distal portion of femur II, on all but the ventral flange of femur III, and all of femur IV (Figs. 4–7). Setation (I–IV, solenidia in brackets), trochanters (1-1-2-1), femora (4-4-3-2), genua (3(1)-3(1)-1(1)-2), tibiae (4(2)-3(1)-2(1)-2(1)), tarsi (15(2)-15(2)-15-12). Ventrodistal edge of femora III and IV with spur, that of femur III strengthened basally. Unguinal setae (*u*) of tarsi I–IV short, wide basally, abruptly tapered at tip. Tactile setae of all legs barbed except for those on the dorsal and lateral surfaces of tibiae and tarsi. Distal setae of tarsi, in particular *tc, it, a* and *p,* attenuate at tip.

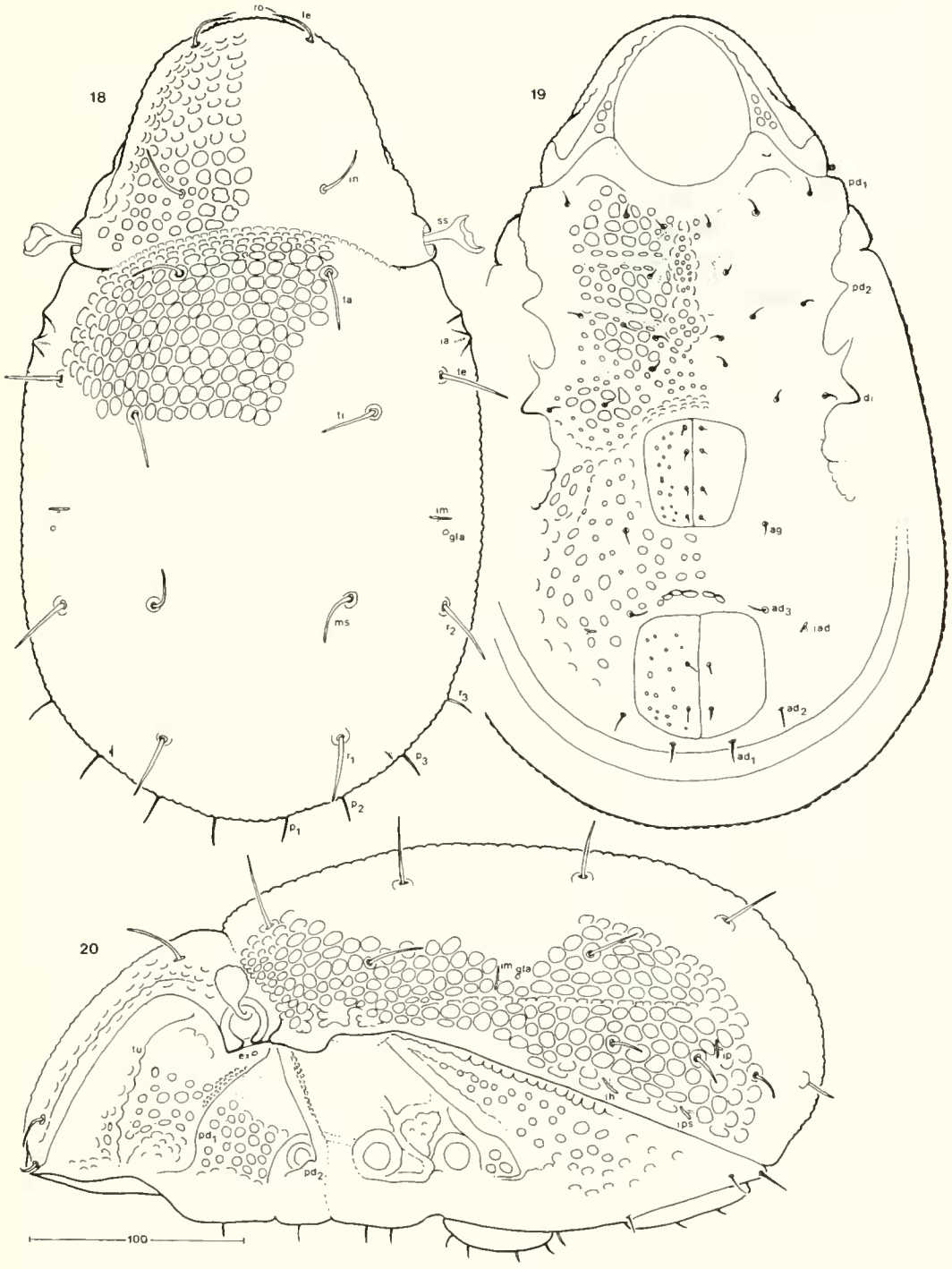
Immatures.—Unknown.

Material examined.—*Holotype:* ♂, Sea Cliff, Long Island, New York, May, N. Banks, from dead fungus (*Polyporus*), mounted in balsam. "Cotypes": 1 ♀, 1 ♂, same collection data as holotype, in alcohol. The holotype slide has on the label "(3 left)" and probably refers to a third "cotype" mounted ventrally and mislabelled according to Norton (1978) as *Carabodes dorsalis.* This specimen was not seen. The holotype and "cotypes" are in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. Additional specimens were examined from USA: Georgia, North Carolina, West Virginia, Pennsylvania, New Jersey, Vermont, New Hampshire; CANADA: Ontario, Québec, New Brunswick, Nova Scotia, Newfoundland. This species is thus widely distributed in eastern North America from the southern Appalachians to Newfoundland (Fig. 17).

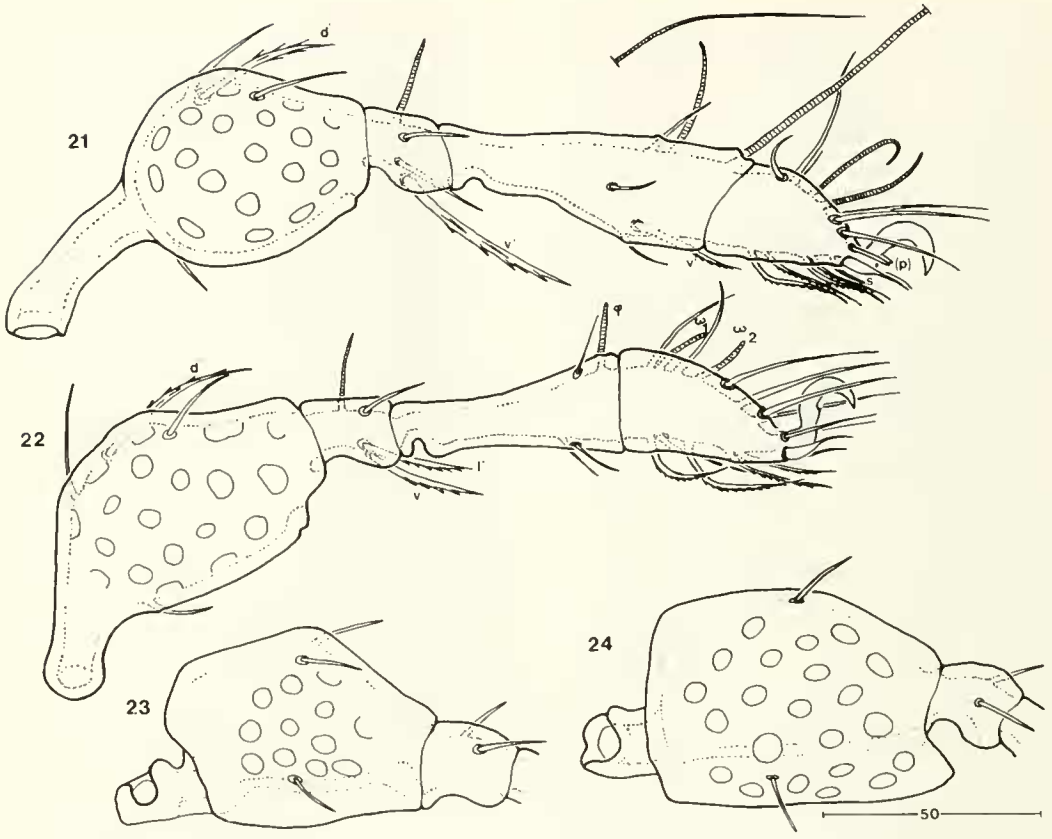
The collections examined which contain *C. brevis* are from a wide variety of forest habitats including leaf litter, rotten wood, moss, lichens, bark and fungi. Rarely has a sample of leaf litter or rotten wood contained more than three specimens while samples which include *Polyporus* fungi may contain as many as eight specimens and the largest collection examined (25 specimens) came from "loose bark with moss, lichens on birch trunk" from Newfoundland. *Carabodes niger* is present and usually in greater abundance in nearly all of my collections of *C. brevis.*

Carabodes higginsi **Reeves**
NEW SPECIES
Figs. 18–35

Diagnostic characters: Prodorsum with medium sized pits (5–7 diameter); dorsosejugal depression a narrow furrow; notogaster covered with tubercles (7–10 diam-



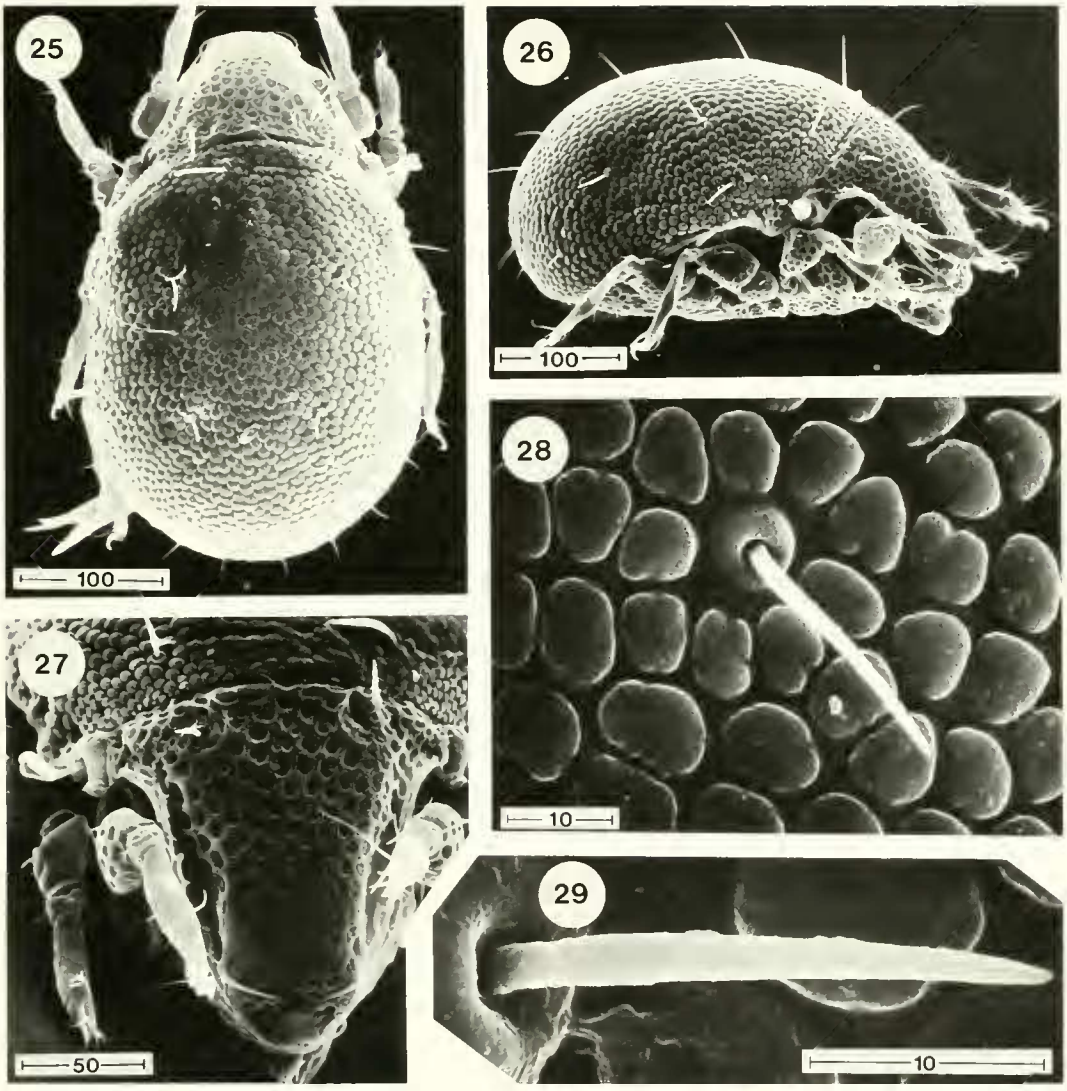
Figs. 18–20. *Carabodes higginsi*, adult. 18, Dorsal view. 19, Ventral view. 20, Lateral view. Scale bar in μm.



Figs. 21–24. *Carabodes higginsi*, adult. 21, Leg I. 22, Leg II. Femur, genu, tibia and tarsus. 23, Leg III. 24, Leg IV. Femur and genu. Antiaxial views. Scale bar in μm.

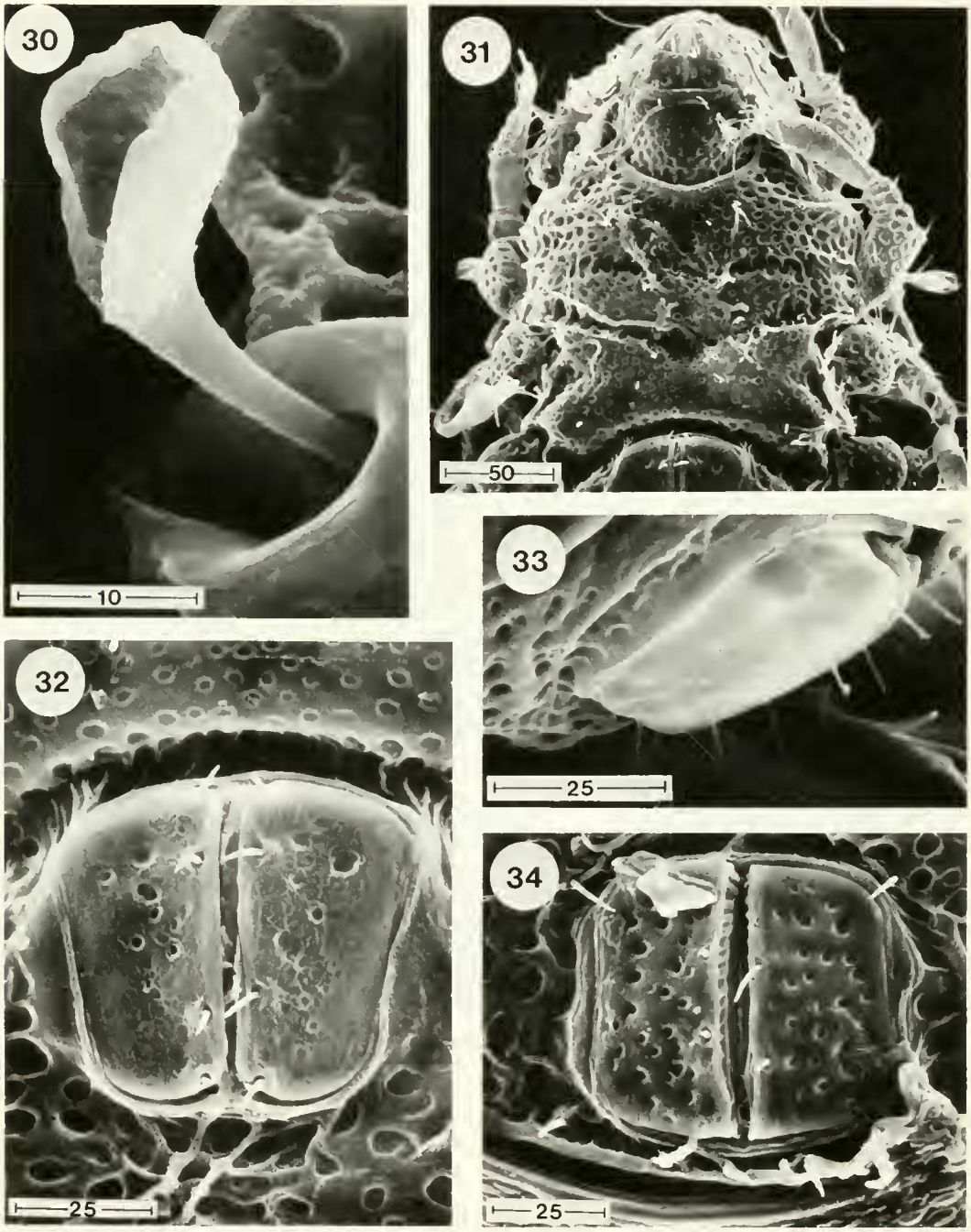
eter); all body setae setiform, notogastral setae arise from tubercles, *ta, ti* and *ms* ⅓ distance to next setal insertion; sensillus capitate, invaginated distally; 0–2 aggenital setae.

Adult.—*Measurements* (mean (range), n = 9 for ♀, n = 2 for ♂): Total length: ♀ 378 (355–390), ♂ 338 (315–360). Notogastral width: ♀ 221 (205–230), ♂ 192 (180–205). Height: ♀ 183 (170–195), ♂ 162 (145–180). *Integument:* Light brown. Thin cerotegument seen only on prodorsum. *Prodorsum:* Prodorsal length: ♀ 103 (95–110), ♂ 88 (85–90). Dorsosejugal depression a narrow furrow. Prodorsal surface (Figs. 18, 27) covered with pits (diameter 5–7), pits generally more circular in middle of prodorsum, extend to lateral edge of lamellae. Rostral (*ro*) and lamellar (*le*) setae setiform, bent medially, closely appressed to prodorsal surface, very minutely barbed at 1000×, *le* (length 27) longer than *ro* (length 17). Interlamellar setae (*in*) (length 32) longer than *le*, setiform, slightly arched. Sensillus (*ss*) (Figs. 18, 30) capitate with distal surface invaginated, forming an irregularly edged cup-like opening. Edge of bothridium with ventral notch (Figs. 20, 30). *Notogaster:* Notogaster (Figs. 18, 25) covered with tubercles (diameter 7–10), sometimes so closely appressed so as to partially flatten adjacent surfaces (Fig. 28). Circumnotogastral depression not apparent dorsally and only barely visible in lateral view (Fig. 20). Two short ridges present on lateral edge of notogaster just posteriad of humeral angle (Fig.



Figs. 25–29. *Carabodes higginsi*, adult. 25, Dorsal view (300×). 26, Lateral view (253×). 27, Prodorsum, anterior view (504×). 28, Notogastral tubercles around seta *ti* (2270×). 29, Seta *ms* (6400×). Scale bars in μm.

18). Lyrifissure *ia* present on posterior ridge. Notogastral setae (Figs. 18, 29) setiform, erect, seta *ta* longest (35–38), others decreasing in length posteriorly to posteromarginal setae (p_1–p_3, 15–20); each seta arising from middle of tubercle (Figs. 28, 29); *ta* and *ti* extending approximately ⅓ to ½ distance to insertion of *ti and ms*, respectively. Seta *ta* positioned anterior to *ti*, thus notogastral setae forming two rows: *ta*, *ti*, *ms* and r_1 medially and *te* and r_2 laterally. *Gnathosoma*: Pits and setae on mentum as shown in Fig. 31. Palpal formula: 0-2-1-3-9 (+ 1 solenidion). *Ventral surface:* Pits present on all ventral surfaces, pits variable in size and shape, generally smaller than those on center of prodorsum, smallest on genital and anal plates. Epimeral plates (ep_1–ep_4, Figs. 19, 31) divided by furrows, epimeral setal formula 3-1-3-3, setae setiform, short



Figs. 30–34. *Carabodes higginsi*, adult. 30, Sensillus (3670×). 31, Ventral view of gnathosoma and epimera (460×). 32, Genital plates (1100×). 33, Lateral view of genital plates (1390×). 34, Anal plates (890×). Scale bars in μm.

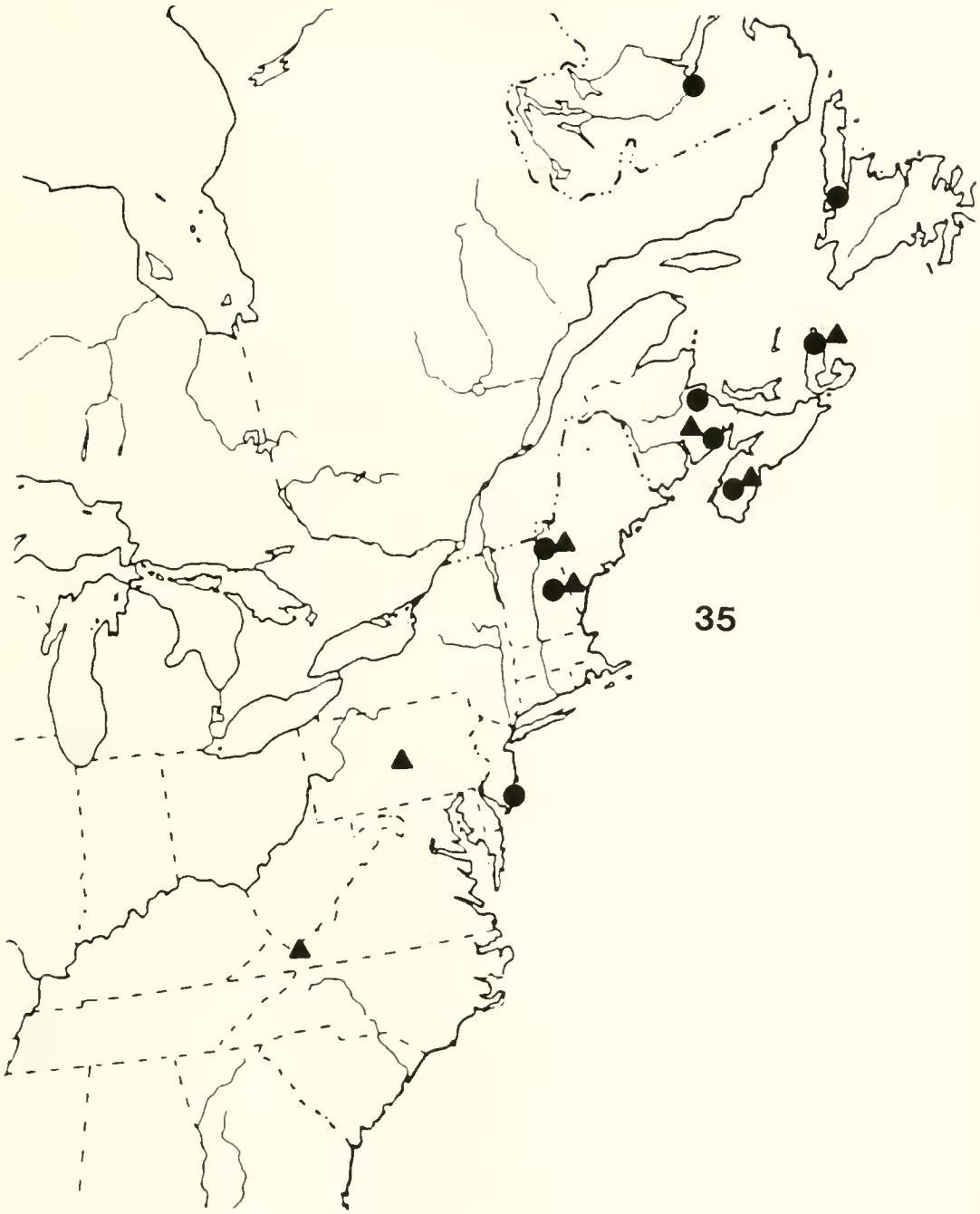


Fig. 35. Known North American distribution of *Carabodes higginsi* (▲) and *C. willmanni* (●).

(8–9). Genital, anal and aggenital setae setiform, short (8–9). One pair of aggenital setae (Figs. 19, 33) present in 8 of 9 females and 3 of 6 males, only one *ag* present on one female and one male and *ag* absent in two males. Adanal setae setiform, length of ad_3 similar to *ag*, ad_2 and ad_1 longer with ad_1 approximately twice length of ad_3. Lyrifissure *iad* lateral to ad_3. Pedotecta I and II and discidium present as shown in Figs. 19, 20. *Lateral surface:* Most of lateral surface below edges of lamellae, bothridium and notogaster but above leg insertions without pits (Fig. 20). Small tubercles present in area immediately above acetabulum I and partially hidden by pedotectum I and on posterior edge of integumental fold that extends from humeral angle ventrally to acetabulum II. Alveolar remnant of exobothridial setae (*ex*) present immediately below bothridium. Circumnotogastral depression faintly indicated below *im* and seta *ms*. *Legs:* Pits present on antiaxial surfaces of femora I and II and trochanters and femora III and IV (Figs. 21–24). Setation (I-IV, solenidia in brackets), trochanters 1-1-2-1, femora 4-4-3-2, genua 3(1)-3(1)-1(1)-2, tibiae 4(2)-3(1)-2(1)-2(1), tarsi 15(2)-15(2)-15-12. Ventral flange of femur III weakly developed. More leg setae are glabrous in *C. higginsi* than in *C. brevis* with the barbed condition retained on paraxial setae *d'* on femora I and II, *v'* on genu I, *v'* and *l'* on genu II, *v'* on tibia I and antiaxial setae *v''* on tibiae III and IV. Solenidion (φ) of tibia II shorter than in *C. brevis* and similar in size and shape to tarsal II solenidia ω_1 and ω_2, a condition also noted by Bernini (1976) for *C. minusculus*. Setae (*p*) of tarsus I short, blunt-tipped and only slightly longer than *s*. Distal setae of all tarsi, in particular *tc*, *it*, *a* and *p* (except leg I), attenuate at tip.

Immatures.—Unknown.

Material examined: Holotype: adult ♀, USA, NEW HAMPSHIRE, Carroll Co., 2.5 mi. NW Wonalancet, The Bowl, VIII-6-85, RMR, sifted spruce litter; deposited in Canadian National Collection. *Paratypes:* 1 ♀, same data except X-1-85, DSC, sifted conifer leaf litter; 1 ♀, same data except VII-30-85, DSC, sifted hemlock/fir leaf litter; 1 ♂, same data except VI-21-85, DSC; 1 ♂, same data except VIII-6-85, sifted litter by stream; 1 ♂, Strafford Co., College Woods, Durham, IV-8-65, RMR, moss on log; 1 ♀, same data except VIII-7-85, sifted leaf litter, rotten wood and stumps; 1 ♀, 1 ♂, 3 sex undetermined, Coos Co., 17 mi. N Crystal, IX-9/11-83, A. Godfrey, extracted from spruce branches; 2 ♀, same data except extracted from fir branches; 1 ♂, same data except 3 mi. NE Errol, IX-3/4-83, extracted from fir branches; 1 ♀, PENNSYLVANIA, Huntington Co., Alan Seeger Natural Area, V-30-85, DSC, sifted pine leaf litter; 1 ♀, VIRGINIA, Giles Co., White Pine Lodge nr. Mountain Lake, IX-12-67, J. M. Campbell, white pine duff; 1 ♀, CANADA, NOVA SCOTIA, Cape Breton Highlands Natl. Pk., Paquette Lake Trail, VIII-29-84, V. Behan, lichens on rocks on Glasgow Lake Trail; 1 ♂, Kejimkujik Natl. Pk., VIII-17-68, E. E. Lindquist, *Polyporus* on dead fir and spruce trunks; 1 ♂, 12 sex undetermined, same data except VIII-18-68, 1' white pine duff. Paratypes deposited in United States National Museum, Washington, D.C., Museum of Comparative Zoology, Cambridge, Massachusetts, Canadian National Collection, Biosystematics Research Centre, Ottawa and the personal collections of R. A. Norton and the author.

This species is distributed from the Canadian Maritime Provinces southwest to Virginia. It has been collected most often from conifer leaf litter, bark and branches and usually as single specimens. Fir and spruce branches and white pine duff have provided the largest number of specimens/sample.

Remarks.—*Carabodes higginsi* belongs to the *minusculus* group by having the notogaster covered with tubercles, a narrow dorsosejugal furrow and by the shape of the sensillus. It has longer and more tapered notogastral setae than *C. willmanni*, which

is the only other species of this group known from North America. The absence of aggenital setae in this group has been noted only in *C. pulcher* Bernini (Bernini 1976).

This species is named after an oribatologist and friend, the late Harold G. Higgins, of Salt Lake City, Utah.

Distribution and Habitat Comparisons

The distribution and habitat preferences for the remaining five species are based on literature, material in the CNC and my own personal collection.

Carabodes granulatus is known from Illinois, Kentucky, New York and North Carolina (Marshall et al. 1987). The additional specimens seen are from Newfoundland, Nova Scotia, New Brunswick and Ontario in Canada and New Hampshire, Vermont, Massachusetts, Pennsylvania, Virginia, South Carolina, Georgia, Florida, Mississippi, Missouri and Oklahoma in United States. It has possibly the widest distribution in eastern North America of any *Carabodes* species and is found from Newfoundland south to northern Florida and west to southern Ontario, Missouri and Oklahoma (Fig. 36). It is also one of the most abundant species in leaf litter and rotten wood samples from Pennsylvania and New Hampshire but may also be found in sphagnum and other mosses, lichens, bark, grass sod and fungi.

Carabodes labyrinthicus is a commonly collected Holarctic species in Europe and North America. It has the most northerly distribution of any *Carabodes* in the Nearctic zone (Fig. 37). Marshall et al. (1987) lists this species from Québec, Northwest Territories, Yukon Territory, Alaska and Virginia. The CNC and my own collection have additional specimens from CANADA: Labrador, Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Ontario and Manitoba and USA: Maine, New Hampshire, Vermont, New York, Pennsylvania and New Jersey. The CNC also has specimens from Magadan, Magadan Region, USSR. It is the only species of *Carabodes* I have collected above 1220 m elevation on Mt. Washington, New Hampshire with the highest collections at 1585 m elevation. The highest numbers I have seen in samples have come from leaf litter and rotten wood from New England, although specimens were also present in samples from moss, lichens, grass, fungi and wrack. Seyd and Seaward (1984), in their review of oribatid mite/lichen associations, consider that this species, while showing a preference for lichens, is also adapted for existence on other plants.

Carabodes niger has been recorded from New York, Ohio, Virginia and North Carolina (Marshall et al. 1987). Additional specimens in the CNC and my own collection extend this distribution to Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Québec, Ontario and Manitoba in Canada and Maine, New Hampshire, Vermont, Massachusetts, Pennsylvania, New Jersey and Maryland in the United States (Fig. 38). It is difficult at this time to determine the southerly distribution of this species below Pennsylvania and Maryland because material I have seen from further south contain many as yet undescribed species closely related to *C. niger*.

Norton (1978) has pointed out that the length of the posteromarginal setae on specimens from Ohio are longer, nearly reaching the insertion of the next seta, while on type specimens from New York these setae are less than half this distance. I have also noted this and find the longer setal lengths predominate in samples from northern New England and Canada while shorter setal lengths predominate in samples from Massachusetts (Martha's Vineyard), New York (Long Island), New Jersey, Maryland and Pennsylvania. A detailed study of *C. niger* and closely related species will be necessary to resolve whether *C. niger* is a complex of species or simply showing clinal variation with latitude.

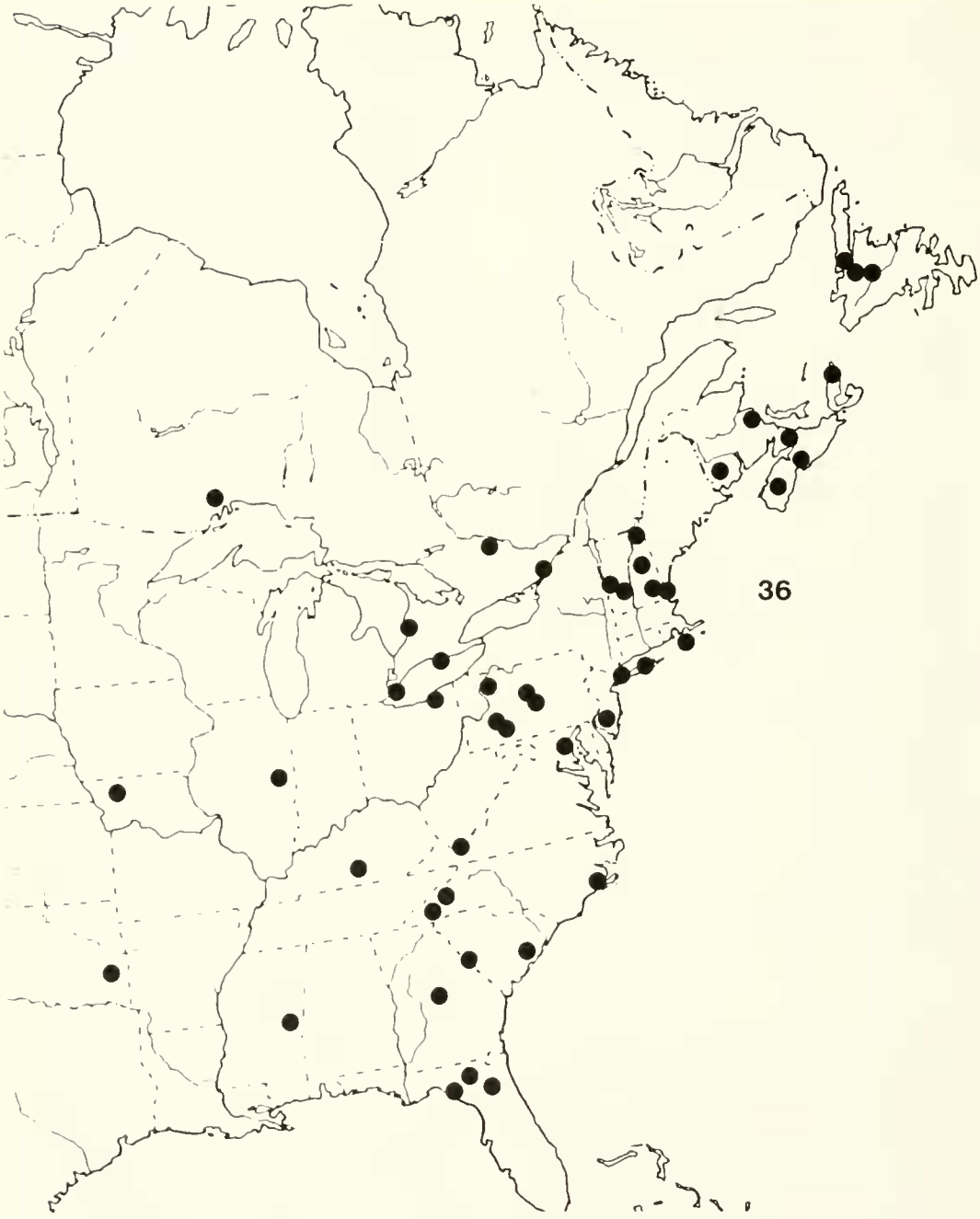


Fig. 36. Known North American distribution of *Carabodes granulatus*.

Banks (1895) collected the type specimens from *Polyporus* fungi, and Norton (1978) noted that most collections from New York and Ohio have been from fungi, especially *Polyporus*. There are many collections in the CNC labelled "bracket fungi" and "*Polyporus* fungi" in association with logs, stumps and tree trunks. The dominant

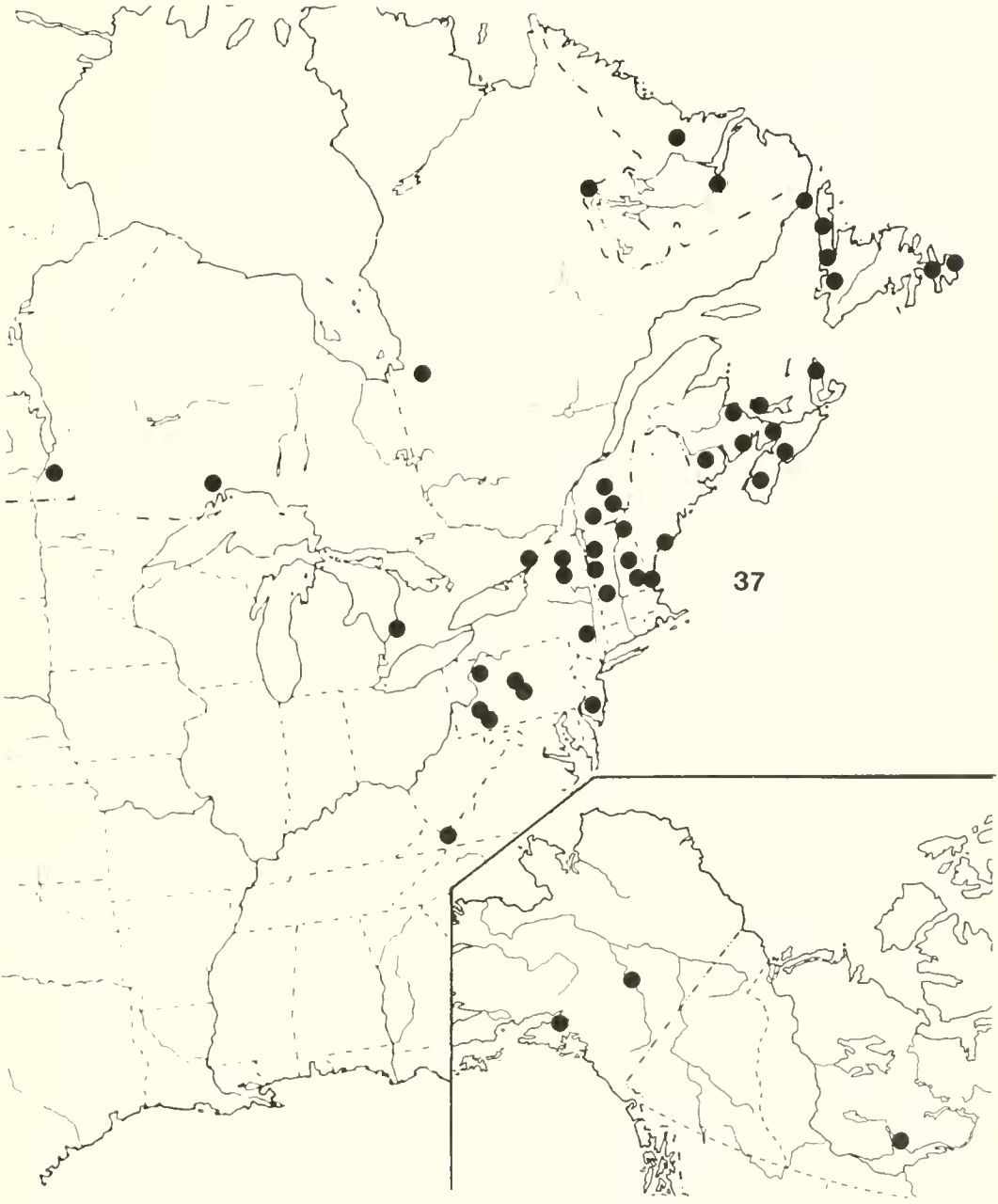


Fig. 37. Known North American distribution of *Carabodes labrynthicus*.

species in these samples is nearly always *C. niger* while the species most often found with *niger* is *C. brevis*. In my collection nearly all samples containing *C. brevis* also contain *C. niger* with the latter species dominant numerically. Thus, a close habitat association between these two species is evident. However, I have usually found *C. niger* is more abundant in forest leaf litter and the most commonly encountered *Carabodes*

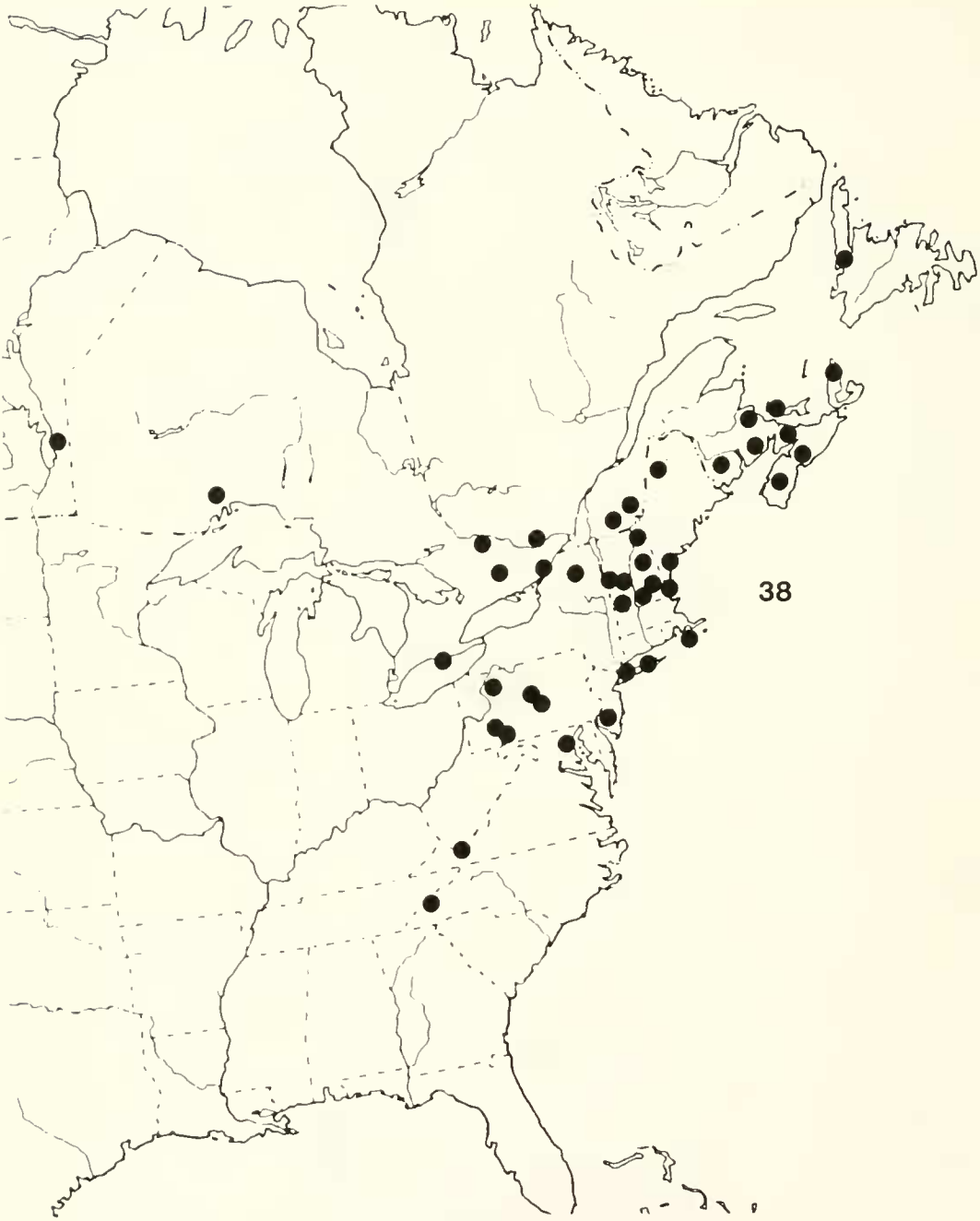


Fig. 38. Known North American distribution of *Carabodes niger*.

species from forest leaf litter, rotten wood, bark and fungi in Pennsylvania and northern New England. It has also been collected from moss, lichens and grass sod.

Carabodes willmanni is Holarctic and is distributed in Europe from Scandinavia south to Italy and Spain and known in North America only from central New Hampshire

Table 1. Percent representation of *Carabodes* species from branch extractions and from sifted leaf litter/rotten wood collections.

Species	Branch Extractions of Spruce-fir	Sifted Leaf Litter/Rotten Wood	
		Spruce-fir	Mixed forest
brevis	52	<1	<1
dendroetus	37	0	<1
higginsi	5	0	<1
willmanni	2	0	0
granulatus	2	<1	41
niger	<1	11	46
labrynthicus	<1	87	2
Other spp.	0	1	11
Total specimens	129	3546	1602

(Bernini 1975). I have seen additional material from Labrador, Newfoundland, Nova Scotia, New Brunswick, New Jersey and from spruce and fir branches in northern New Hampshire (Fig. 35). Samples with the largest number of specimens (43 maximum) are from lichens or lichens mixed with woody shrubs while samples from leaf litter, moss, bark or grass contain one to three specimens only. In Europe *C. willmanni* is a common inhabitant of lichens (Bellido 1979, Colloff 1983, Seyd and Seaward 1984) and Bellido (1979) has reported on the influence of temperature and moisture on the seasonal abundance of larvae, nymphs and adults of this species while feeding in lichens.

Table 1 gives the percentages of individuals recovered from branch samples processed with caustic soda and compares them with leaf litter/rotten wood samples from a virgin spruce-fir stand at Norton Pool, 3 mi. E of East Inlet Dam, Coos Co., NH, and a virgin mixed forest at "The Bowl," 2.5 mi. NW Wonalancet, Carroll Co., NH. A more complete description of these areas may be found in Lyon and Reiners (1971). The dominant *Carabodes* species on branches were *brevis* and *dendroetus* while leaf litter/rotten wood was preferred by *C. granulatus, niger* and *labrynthicus. Carabodes willmanni* and *higginsi* were absent or poorly represented in all these habitats suggesting that these are not favored habitats for these species. All seven species were collected from spruce branches while only four (*C. brevis, dendroetus, higginsi* and *granulatus*) were collected from fir branches. Also 85% (56 specimens) of *C. brevis* were collected from spruce branches. Thus spruce branches seem to be preferred to those of fir, possibly as a result of the rougher bark surface or the position of the needles around the twigs.

In summary the above evidence indicates considerable variation in habitat preferences for certain species. *Carabodes brevis* and *dendroetus* are primarily arboreal with *C. brevis* often associated with *C. niger* in fungal fruiting bodies. *Carabodes granulatus, labrynthicus* and *niger,* while more common in leaf litter/rotten wood, may be arboreal, with *granulatus* and *labrynthicus* usually associated with lichens and moss and *niger* with fungi. *Carabodes willmanni* is probably limited to bark and branches where lichens are present. The caustic soda wash technique did not indicate habitat preferences for *C. higginsi* but other collection information point toward a preference for coniferous litter or bark.

Acknowledgments

Scientific Contribution Number 1546 from the New Hampshire Agricultural Experiment Station.

The Central University Research Fund,

University of New Hampshire, provided financial support for scanning electron micrographs used in the descriptions. I thank Stanley S. Swier and April Godfrey for providing the extracted branch samples, Donald S. Chandler for collecting many of the leaf litter/rotten wood samples and Valerie Behan-Pelletier for providing access to the CNC material. I am grateful to Ardis Johnston, Museum of Comparative Zoology, Cambridge for the loan of the type specimens of *C. brevis*. I thank Valerie Behan-Pelletier, Biosystematics Research Centre, Ottawa, Canada and Donald S. Chandler and John S. Weaver III, University of New Hampshire, for review of the manuscript.

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